

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:

Joseph R. Summa

OPTIMIZATION OF CCD  
MICROLENS SIZE FOR COLOR  
BALANCING

Serial No. 09/821,151

Filed 29 March 2001

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA. 22313-1450

Sir:

Group Art Unit: 2612

Examiner: Nguyen, Luong Trung

I hereby certify that this correspondence is being deposited today with the United States Postal Service as first class mail in an envelope addressed to Commissioner For Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

*Robin G. Reeves*  
~~For: [Signature]~~ *Robin G. Reeves*  
*12/28/04*  
Date

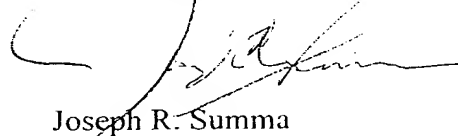
**DECLARATION UNDER 37 CFR 1.132**

Joseph R. Summa declares that he is the inventor of the subject US Patent Application, who on March 29, 2001 filed the above-identified application; that he conceived his invention in this country long prior to August 10, 2000 (hereinafter the first effective filing date), the filing date of Foster, US Patent 6,643,386, entitled Method and Apparatus For Adding Watermarks To Images and/or Video Data Streams and prior to September 22, 2000 (hereinafter the second effective date), the publication date of Omori et al. entitled Solid-State Image Pickup Element And Its Manufacture; that long prior to either of the effective dates he prepared a description and drawings of his invention, a photostatic copy of which is attached hereto; that he worked substantially continuously with his attorney from March 17, 2000 until the application was mailed to the United States patent office on March 29, 2001; that the actual dates he net with his attorney can't be supplied herewith because the electronic calendaring system used automatically deletes calendar entries after 45 days; that he does not know and does not believe that his invention has been in public prior to his application, and that he has never abandoned the invention.

He further declares that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with knowledge

that willful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully Submitted,

A handwritten signature in black ink, appearing to read "Joseph R. Summa", written over a horizontal line.

Joseph R. Summa

12/28/04

# Optimization of CCD Microlens Size for Color Balancing

Joseph R. Summa

## Field of Invention

This invention relates to electronic imaging, and in particular the color sensitivity of individual pixels in a CCD.

## Background of Invention

The responsivity of a CCD typically varies with the wavelength of the incident light. This variation is caused by a variety of factors including the gate electrode and dielectric stack, color filter non-idealities, and the sensitivity of the silicon itself. Typically, the spectral response of a CCD peaks in the green and is lowest in the blue. There is also much less blue light available in typical scenes making larger sensitivity to blue light desirable. This invention preferentially directs portion of the light that would otherwise be captured by pixel with high responsivity onto a pixel with lower response and thus permit optimization of the total spectral sensitivity of the device.

## Summary of the Invention

Microlens arrays deployed on CCDs are typically sized identically for each color and match the dimension (less the gap between lenses) of the underlying pixel. By uniquely sizing the microlenses over each color, (and expanding outside the bounds of the underlying pixel if necessary), the spectral response of the device can be customized.

## Advantages over Prior Art

- \* Improved color balance without significant loss of light
- \* Improved blue response
- \* Less sensitivity to lens inefficiencies when applied to a full frame CCD

## Detailed Description of the Invention

A typical lens array is shown in figure 1. An example of a resized lens array is shown in figure 2. In the (somewhat exaggerated) case shown, an oversized blue lens focuses a percentage of the light that would have been collected in the green pixel using the standard design in figure 1. This additional light can be used to compensate for spectral sensitivity differences. Due to changes in the curvature of the lens as function of lens size, not all lenses will focus light on the substrate with equal efficiency. When applied to an interline CCD with a narrow photodiode, this will reduce the quantum efficiency of these pixels, but still improve color balancing. In the case of full frame image sensors (where the entire pixel is photosensitive), these losses (if any) will be much less severe since the diameter of the focus spot of the lens is less critical.

## Examples of Prior ART:

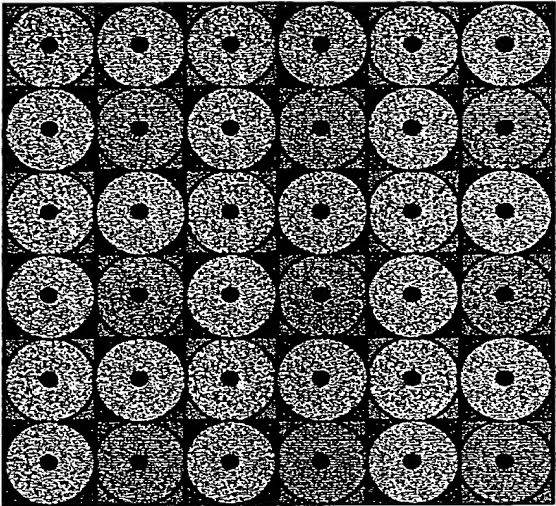
US PAT. 4,667,092 ← USE OF LENSLETS

US PAT. 6,001,668 ← ITO<sup>FULL FRAME</sup> SENSOR w/ MENTION OF LENSLET TO FOCUS LIGHT INTO ITO PHASE  
(KODAK)

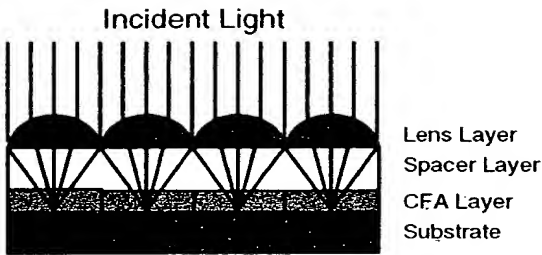
3/17/2000 H. J. Jordan

3/17/2000 Joseph Summa

Attachments

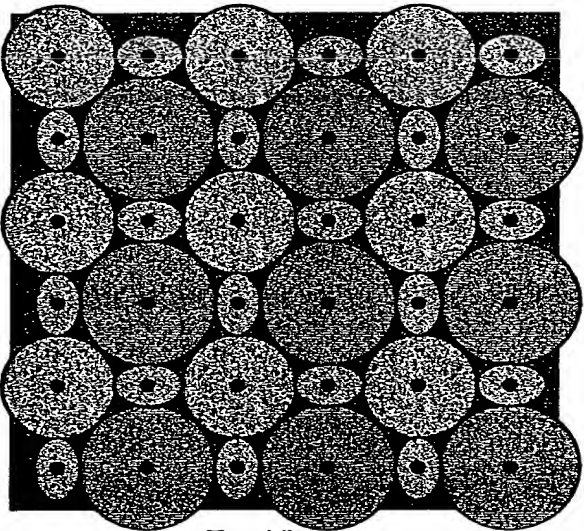


Top View

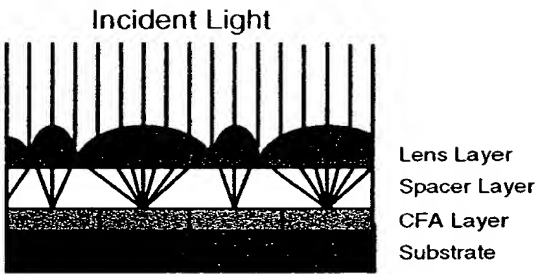


Cross Sectional View

Figure 1



Top View



Cross Sectional View

Figure 2

3/17/2000 K. H. J. J. J.  
3/17/2000 J. H. J. J. J.